



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.549

IJFAS 2018; 6(2): 427-430

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www.fisheriesjournal.com

Received: 22-01-2018

Accepted: 23-02-2018

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A review on role of fish in human nutrition with special emphasis to essential fatty acid

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Abstract

Fish is one of the most important foods in human diet because of its high nutritional quality. They are the well known source of a group of polyunsaturated fatty acids (PUFAs) especially omega-3 and omega-6, which can prevent atherosclerosis and thrombosis. These fatty acids have preventive effects on coronary heart diseases, autoimmune disorders, arrhythmias, lowering plasma triglyceride levels and blood pressure. Almost all the minerals present in fish which is required our body. The minerals present in fish iron (Fe), Calcium (Ca), Zinc (Zn), Phosphorus (P), Selenium (Se), Fluorine (F), Iodine (I). These minerals are with high bioavailability; they can easily absorbed by the body. In this review up-to-date information about importance of fish in human nutrition and beneficial effect of essential fatty acid in human health is also reviewed.

Keywords: Fish, nutrition, essential fatty acid, proximate composition

Introduction

The world fish production is 167.2 million tons, out of which 146.3 million tons is used for human consumption and remaining is used as non-food purpose and discarded as waste material (FAO, 2016) [9]. The demand for high quality fish and fishery products is growing significantly every year mostly due to their nutritional fact that they contain plentiful of beneficial healthy substances (FAO, 1986) [8]. The most important of these are fish lipids, which usually contains high amount of omega-3 fatty acids, mainly α -linolenic acid, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). The omega-3 fatty acids have several beneficial impacts on human health. These include decreasing the risk of myocardial infarction (Bucher *et al.*, 2002) [4] lowering blood pressure and triglyceride concentration in blood (Harris *et al.*, 1997; Vandongen *et al.*, 1993) [12, 21] enhancing the immune system (Damsgaard *et al.*, 2007) [6] and sustaining proper brain function in human body. They also protect against various psychological disorders, depression and attention deficit hyperactivity disorder in particular (Sinn, 2007) [19] and cancer (Caygill and Hill, 1995) [5]. Nevertheless, fatty acids are not the only important nutrients in the fish and fishery products, it is also a good source of easily digestible protein, and its amino acid profile usually contains most of the essential amino acids which is required to humans for balanced diet. They are also rich source of fat-soluble and B-group vitamins (Erkan and Bilen 2009) [7]. The aim of this review mainly focuses on the important nutritional component in fish with special emphasis on essential fatty acid and their impacts on human health.

Proximate Composition

The proximate composition is a term usually used in the field of food or feed and its main components include moisture, ash, lipid, protein, and carbohydrate content which are expressed as the content percentage. Proximate composition of almost all the food fishes have been studied by different authors although variation in composition based on their nutritional quality depend largely on their feeding habits, season, adaptation temperature, age, sex, and state of spawning availability of feed etc. The Proximate composition of a number of marine, freshwater and brackish water fish has been reported (Gopakumar, 1997) [11]. Proximate constituents together form about 95-98% of the total weight of the tissue. A variety of many other minor constituents are also present in small quantities, like carbohydrate, vitamins, free

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amino acids and non-protein nitrogenous compound. These food components may be of interest in the food industry for product development, quality control or regulatory purposes.

Principal Constituents of fish muscle

Constituent	Percentage (%)
Moisture	66-71
Protein	16-21
Lipid	0.2-25
Ash (Minerals)	1.2-1.5

The biochemical composition of fish varies widely and these variations are determined by many factors such as biological status in the life cycle, feeding habits and environmental conditions (Gopakumar, 2002) [10]. Mazumder *et al.*, (2008) [15] analyzed the proximate composition of some small indigenous fish species in Bangladesh and found that the protein content varied from species to species. However, the author states that the proximate compositions of different small indigenous fish are more or equal to other larger fish species. Thammapat *et al.*, (2010) [20] studied proximate and fatty acids composition of the muscles and viscera of Asian catfish (*Pangasius bocourti*) and reported that the contents of protein, moisture and ash were inversely proportional to lipid content. Viscera had the highest lipid content followed by ventral and dorsal had the lowest.

Sankar and Ramachandran (2001) [17] reported that the proximate composition of fish depends on various factors such as sex, size, stages of maturity and season. It has also been reported that factor such as feed composition, environment, fish size, and genetic trait all have an impact on the composition and quality of aquaculture fish (Reinitz *et al.*, 1979) [16].

Major Biochemical Constituents of Fish Muscle

Moisture

The main component of fish flesh is water, which usually accounts for about 80 per cent of the weight of a fresh meat of fish. Whereas the average moisture contents of the flesh of fatty fish is about 70 percent, the highest moisture contents founds in Bombay duck with 90%. The water in fish muscle is tightly bound to the proteins in the structure in such a way that it cannot readily be expelled even under high pressure. After prolonged chilled or frozen storage, however, the proteins are less able to retain all the water, and some of it, containing dissolved substances, is lost as drip.

Protein: -

Fish and shellfish provide about 14% of the worlds need for animal proteins and 4% to 5% of the total protein requirement (Venugopal, 1995) [22]. Amino acid composition and the digestibility of fish proteins are excellent about 85-95%. Fish are regarded as an excellent source of high-quality protein, particularly the essential amino acids lysine and methionine. In addition to the high nutritional value, fish proteins also have good functional properties such as water-holding capacity, gelling, emulsification, and textural properties for the products such as fish mince and surimi, the water-holding capacity and the gelling properties which determine the textural attributes of the products are important quality parameters (Venugopal, 1995) [22]. The amount of protein in fish muscle is usually between 16 and 21 %, but values lower than 16 % or as high as 28 % are occasionally found in some species. Proteins are important for growth and development of the body, maintenance and repairing of worn out tissues.

Protein content of fish muscle depends on species, nutritional condition and type of muscle. Fish proteins are having high biological value as they contain all essential amino acid in the right proportional and specially, lysine as well as sulphur containing amino acid such as methionine and cysteine which are absent in plant protein.

Lipids

Lipids are those substances which are insoluble in water soluble in organic solvents such as chloroform, ether or benzene they contain long-chain hydrocarbon groups in their molecules; and derived from living organisms (Kates, 1986) [13]. They play an important role in maintaining the integrity of plants and animals as structural compounds by forming a barrier separating the living cell from the outside and they are the major source of cellular energy and function in living organisms where they can be stored. The lipid content of fish varies depending on the species as well as season but generally, fish have less fat than red meats. The fat content ranges usually from 0.2 to 25% as the fat content rises, so the water content falls and vice versa. Fish lipids are known to provide high contents of important components for the human diet, such as nutritional lipid-soluble vitamins (A and D) and essential fatty acids ω3 polyunsaturated fatty acids (PUFA) that have shown a positive role in preventing certain human diseases, including cardiovascular ones (Simopoulos,1997) [13]. Usually Marine fish lipids, however, differ from the other lipids in that they longer-chain fatty acids, and a larger proportion of highly unsaturated fatty acids (Ackman 1989) [1].

Essential Fatty acid

Fatty acids are natural components of fats and oils. They are classified based on their chemical structure into three groups: saturated, mono-unsaturated and poly-unsaturated fatty acids. Saturated fatty acids are mainly found in animal foods, such as meat, lard, sausage, butter and cheese but even in palm kernel and coconut oil, which are used for frying. Unsaturated fatty acids are mainly in fatty fish origin. Polyunsaturated fatty acids (PUFAs), there are two different groups: the 'omega-3-fatty acids' and 'omega-6-fatty acids' Both are considered as essential fatty acids because they cannot be synthesized by humans therefore must be obtained from diet or supplementation (Kris-Etherton *et al.* 2002) [14]. Omega-3s are a family of long-chain polyunsaturated fatty acids that are essential nutrients for health and development. Research indicates that there are two most beneficial omega-3s are EPA (Eicosapentaenoic acid) and DHA (docosahexaenoic acid) they have several beneficial impacts on human health. These include decreasing the risk of myocardial infarction (Bucher *et al.*, 2002) [4] lowering blood pressure and triglyceride concentration in blood (Harris *et al.*, 1997) [12] enhancing the immune system (Damsgaard *et al.*, 2007) [6] and sustaining proper brain function in human body. They also protect against various psychological disorders, depression and attention deficit hyperactivity disorder in particular and cancer (Sinn, 2007) [19].

Minerals

Fish is a good source of almost all the minerals present in seawater and the value range from 0.4 to 1.5% (wet basis).The mineral present in fish include iron, calcium, zinc(from marine fish), phosphorus, selenium fluorine, iodine. These minerals are with high 'bioavailability' meaning that they are easily absorbed by the body (Balachandan, 2002) [3].

Some important mineral constituent of fish muscle

Element	Average value(mg/100g)
Sodium (Na)	72
Potassium(K)	278
Calcium (Ca)	79
magnesium (Mg)	38
Phosphorus (P)	190

Availability of iodine and selenium in marine fish is of special significance from nutritional point of view. Iodine is important for hormones thyroxin that regulate body metabolism and in children it is required for growth and mental development. Selenium is an essential antioxidant trace element. Iron is important in the synthesis of haemoglobin in red blood cells for transporting oxygen to all parts of the body. Calcium is required for strong bones (formation and mineralization) and for the normal functioning of muscles and the nervous system. The intake of calcium, phosphorus and fluorine is higher when small fish are eaten with their bones instead of discarding fish bones.

Vitamins

All the vitamins necessary for good health of humans and they are present in good amount in fish, but the amounts vary widely from species to species and throughout the year. Fish is a great source of particular vitamins which hold very important functions within the body. Oily fish is a rich source of vitamins A and D, which are important in the growth and development of children. White fish is a good source of B vitamins. Vitamin A is necessary for normal growth, formation of bones and teeth, cell building, it prevents poor eyesight and helps in treatment of many eye diseases. Vitamin D helps with correct use of calcium and phosphorus, which are necessary for strong bone and teeth combined with vitamin A and C it helps prevent cold. Vitamin B is important for enzyme functioning which accelerate chemical processes in the body. Vitamin K helps prevent internal bleeding and stimulates correct coagulation of blood. Fatty seafood such as mackerel, herring, salmon and trout are all rich in vitamin A and D. Fish oil taken with vitamin E reduces levels of inflammation, joint swelling, pain and tenderness characteristic of rheumatoid arthritis. Vitamin K present in fish is responsible for anti-hemorrhage factor (Anon 2017)^[2].

Conclusion

Fish and fish products play a great role in the nutritional picture because they are rich source of nutrients and provide a good balance of protein, vitamins and minerals, and a relatively low caloric content. In addition these properties it also excellent sources of Polyunsaturated fatty acids which appear to have beneficial effects in reducing the risk of cardio-vascular diseases and are linked with positive benefits in many other pathological conditions particularly, certain types of cancer and arthritis.

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